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.	not available for any reference period
..	not available for a specific reference period
...	not applicable
0	true zero or a value rounded to zero
0[s]	value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
p	preliminary
r	revised
x	suppressed to meet the confidentiality requirements of the *Statistics Act*
E	use with caution
F	too unreliable to be published
*	significantly different from reference category ($p < 0.05$)

Dynamics of smoking cessation and health-related quality of life among Canadians

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Abstract

Background

People who smoke are at increased risk of lung and other cancers, heart attack, stroke, chronic lung disease and premature death. After smoking cessation, these risks diminish, but little is known about the time required to regain the level of health of people who have never smoked. This analysis describes trajectories of health-related quality of life (HRQL) in relation to smoking status, focusing on the time required for former smokers to achieve an HRQL level similar to that of never-smokers.

Methods

Data were from nine cycles (1994/1995 through 2010/2011) of the National Population Health Survey. Analyses were based on longitudinal data for 3,341 men and 4,143 women aged 40 or older in 1994/1995. Multi-level growth modelling was used to describe HRQL trajectories over the 16-year follow-up period in relation to smoking status, which was updated every two years.

Results

Across all ages and for both sexes, persistent smokers had lower HRQL than did never-smokers. Among men, HRQL improved after 5 years of quitting; after 20 years, HRQL was similar to that of never-smokers. Among women, after 10 years of cessation, the HQRL of former smokers was clinically similar to that of those who had never smoked.

Interpretation

At any age, and for both men and women, long-term smoking cessation results in improvements in HRQL.

Keywords

Health status, longitudinal studies, smoking, statistical models, tobacco

Authors

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Several decades of research have established the causal relationship between tobacco smoking and a variety of adverse health effects.[1] In response, anti-smoking legislation has been enacted (including smoking bans and requirements for health-related warnings on cigarette packages), social norms have shifted, and the percentage of smokers among Canadians aged 15 or older has fallen from 35% in 1985 to 17% in 2010.[2]

Today, fewer people are becoming smokers, and substantial numbers of smokers are quitting.[2] The health benefits of smoking cessation include a reduction of the risk of lung and other cancers, heart attack, stroke, and chronic lung disease.[3] However, quantifying improvements to overall health is challenging, and to date, has been the subject of only limited research.

The dynamics of smoking cessation are complicated.[3] The struggle to quit permanently can be prolonged, involving several attempts (and relapses) before permanent cessation is achieved (or not).[2-4] As well, it may take years of abstinence for disease risk to be similar to that of people who never smoked.[3] Therefore, research aimed at studying the relationship between smoking status and health outcomes must track subjects over periods long enough, and assess them frequently enough, to capture changes in both exposure and outcome.

This study describes trajectories of health-related quality of life (HRQL) in relation to smoking status. A specific focus is a comparison between former and never-smokers, with the aim of quantifying the time required after quitting for the HRQL of former smokers to be similar to that of never-smokers. An important advantage to the analysis was the availability of longitudinal data from the National Population Health Survey (NPHS), which collected information from survey participants every two years over a 16-year period.

Methods

Data source

The analysis is based on longitudinal data from nine cycles (1994/1995 through

2010/2011) of the NPHS. The target population of the NPHS Household component was household residents in the 10 Canadian provinces in 1994/1995, excluding residents of Indian Reserves, institutions, Canadian Forces bases, and some remote areas.

In 1994/1995, 20,095 households were selected for the NPHS longitudinal panel. In each household, one person was selected at random; of these, 86% (17,276) completed the General component of the questionnaire (17,276) in 1994/1995. Since then, attempts have been made to interview the selected respondents every two years. Detailed descriptions of the NPHS design, sample, and interview procedures are available elsewhere.[5,6]

This study analyzes information from respondents who were aged 40 or older in 1994/1995. This age range was chosen because the effect of smoking-related health conditions on HRQL trajectories would be more evident than if a younger population had been used.

Measures

Health Utilities Index Mark 3 (HUI3)

HRQL was assessed using the Health Utilities Mark 3 (HUI3), a generic preference-based measure that reflects the subjective values assigned to specific health-related outcomes.[7] HUI3 quantifies HRQL based on an individual's functional status in eight domains (attributes)—vision, hearing, speech, ambulation, dexterity, emotion, cognition, and pain—each of which has five or six levels, ranging from no impairment to severe impairment. HUI is a measure of functional health that, at least partially, reflects the diseases that an individual might have or be at risk of having. Extensive evidence supports the construct validity of the HUI3 in population health applications.[8-11] Overall HUI3 scores are derived from a multiplicative, multi-attribute utility function based on preference scores obtained from a random sample of the Canadian population,[7] using the conventional scale in which dead = 0.00 and perfect health = 1.00; scores below zero could represent health states considered to be worse than dead. A difference (or change) of 0.03 or more in the score is considered to be clinically meaningful.[9,12,13] This criterion is based, in part, on comparisons of mean scores for known groups in both cross-sectional and longitudinal studies.

Because of the highly skewed nature of the distribution of HUI3 scores, an arcsine transformation of the outcome measure was used to achieve normally distributed residuals.[14]

Smoking status

For every NPHS cycle, each respondent was categorized as a current daily smoker, a former daily smoker who had quit (within the past 4 years, 5 to 9 years, 10 to 19 years, or 20 or more years), or never a daily smoker. If smoking status was missing in a given cycle, but was available in previous and subsequent cycles, this information was used to impute smoking status for the missing cycle. Smoking status was imputed for at least one cycle for 17% of respondents included in this study (11% for one cycle, 4% for two cycles, and 2% for three or more cycles).

Age

Age at interview was centred at 57, which was the mean age of respondents in the sample in 1994/1995 (mean = 56.8 years).

Covariates

Variables representing factors known to be potential confounders of the association between smoking status and HRQL were included in preliminary models. These were: low household income (the lowest 20th percentile of the percentage distribution), education (less than secondary school graduation, secondary school graduation, or postsecondary graduation), marital status (married/living with a partner), and obesity (body mass index of 30 kg/m^2 or higher).

Consideration was given to including age of initiation and duration of smoking in the multivariate models. However, age of initiation, age of observation, duration of smoking, and duration of abstinence are interdependent. Within age groups, age of initiation was similar for current and former smokers. Therefore, inclusion of this variable does not alter the observed benefits of cessation. Although the duration of smoking among former smokers is less than among current smokers (within age group), this is already taken into account by the number of years since cessation.

Analysis

Measures of smoking status were used to predict HUI3 scores two years (one cycle) later. To account for the non-independent nature of repeated measures (HUI3 and smoking status), multi-level growth curve modeling was used. This technique allows for the examination of both intra- and inter-individual differences in HUI3 over age. In the models, smoking status categories were used as time-varying covariates (an individual's smoking status category could change from one cycle to another). For each successive pair of NPHS cycles (1994/1995 to 1996/1997; 1996/1997 to 1998/1999; etc.), a record was created that included smoking status based on data from the first time-period (time 1), and HUI3 and age based on data at follow-up two years later (time 2). Values of HUI3 at time 2 (instead of time 1) were used to allow for a "lag-time" between exposure (smoking) and outcome (health status); age at time 2 was used because of the high correlation between HUI3 and age.

Of the 7,915 respondents aged 40 or older in 1994/1995, 101 were excluded because of missing values for smoking status at all cycles. An additional 330 were excluded because no successive pair of cycles contained a valid response for smoking status at time 1 and HUI3 at time 2. The remaining 7,484 contributed at least one observation to the analysis file. For respondents who died during follow-up, a final record was created to include age at time of death and a HUI3 score of 0.00. When date of death was unavailable, age was assigned the value of age at time 1 plus two years. No further records were included for these respondents.

For each respondent, a maximum of eight observations was possible (59,872

in total). Deaths (after the cycle in which the death was reported) resulted in a loss of 8,381 potential observations, leaving the maximum potential at 51,491. Non-response to smoking status at time 1 or to HUI3 at time 2 resulted in a loss of 8,801 observations (17%), leaving 42,690 observations on the final analysis file. Of the 7,484 respondents, 36% contributed all eight possible observations, 15% contributed seven, 10% six, 8% five, 7% four, 9% three, 8% two, and 7% one. NPHS respondents who move into institutions are followed up and were included in this study.

Previous research has shown that normative HUI3 trajectories differ between men and women[11]; therefore, models were run separately by sex. A two-level model was structured with time (level 1) being nested within individuals (level 2). Arcsine-transformed HUI3 was modeled over age (centred at 57 years), and linear, quadratic and cubic rates of change in HRQL were examined for statistical significance and improvement to model fit (as measured by change in -2 log likelihood). In models for both men and women, a cubic pattern was found to best fit the data (data not shown), capturing the nonlinear association between age and HRQL (arcsine-transformed HUI3).

To examine the association between smoking status and HRQL over time, dummy variables for smoking status categories were included in the models, with never daily smokers as the reference group. Interactions between smoking status category and slope parameters were used to examine the effects of smoking status on change in HRQL scores as individuals aged. All smoking-status-related effects were fixed (not allowed to vary randomly between individuals). Although a single trajectory is presented for each smoking status category, the smoking status category of a respondent could change over time, based on information provided in each interview.

All descriptive statistics were based on weighted estimates. For growth curve modelling, normalized weights were used and applied to the second level of the models (level of the individual). Variance estimates for descriptive statistics were calculated using the bootstrap technique to account for the complex survey design of the NPHS.[15] Variance estimates for the growth curve modelling parameters were inflated using a design effect of two to account for the complex sampling design of the NPHS.

Results

Characteristics of study population

The study sample comprised 3,341 men and 4,143 women aged 40 or older in 1994/1995. During the follow-up period (1996/1997 to 2010/2011), 4% of men and 7% of women in the weighted sample were institutionalized, and 30% of men and 25% of women died (Table 1).

Table 1
Descriptive statistics of weighted sample, by sex, household population aged 40 or older in 1994/1995, Canada excluding territories

	Men (n=3,341)	Women (n=4,143)	p-value Chi-square test (men versus women)
	%		
Institutionalized during follow-up (1996/1997 to 2008/2009)	**3.5**	**6.8***	
Died during follow-up (1996/1997 to 2008/2009)	**29.8**	**25.0***	
Age distribution (1994/1995)			
40 to 49	39.0	33.7*	
50 to 59	25.5	24.7	
60 to 69	19.4	20.3	<0.001
70 to 79	11.9	15.8*	
80 or older	4.2	5.5*	
Smoking status distribution (1994/1995)			
Current daily smoker	26.7	19.8*	
Former daily smoker	49.6	29.6*	
Years since quitting daily smoking			
4 or fewer	7.8	4.6*	
5 to 9	7.7	5.0*	
10 to 19	16.6	8.8*	<0.001
20 or more	17.5	11.2*	
Never smoked daily	23.7	50.5*	
Percentage distribution of number of two-year changes in smoking status (1996/1997 to 2008/2009)			
0	80.6	86.1*	
1	10.8	8.7*	
2	5.1	2.7*	<0.001
3 or more	3.5	2.5	
Percentage with at least one two-year change in smoking status (1996/1997 to 2008/2009), by smoking status in 1994/1995			
Total	19.4	13.9*	
Smoking status 1994/1995			
Current daily smoker	55.7	56.8	
Former daily smoker			
Years since quit daily smoking			
4 or fewer	25.5	32.1	
5 to 9	13.5E	6.1E	
10 to 19	5.0E	4.1E	
20 or more	F	F	
Never smoked daily	F	F	

* significantly different from men ($p<0.05$)
E use with caution
F too unreliable to be published
Source: 1994/1995 to 2010/2011 National Population Health Survey, longitudinal sample (square)

In 1994/1995, men were more likely than women to be current daily smokers (27% and 20%, respectively), and were also more likely to be former daily smokers, regardless of the number of years since quitting. Transitions in smoking status (quitting or relapsing) from one interview to the next were common, particularly among people who, in 1994/1995, were daily smokers or recent quitters (4 or fewer years). More than half of those who were daily smokers in 1994/1995 reported at least one change in smoking status during follow-up; among recent quitters, approximately one-quarter of men and one-third of women reported at least one change.

Table 2 shows the distribution of smoking status at time 1 and mean HUI3 at time 2 across the entire observation period (1994/1995 to 2010/2011), by sex and age group. The likelihood of being a daily smoker declined sharply with age. Also, respondents younger than 60 were less likely to be long-term quitters (20 or more years) than were those aged 60 or older. Women aged 80 or older were far less likely than those in younger age groups to have ever smoked daily.

Over all age groups, mean HUI3 averaged 0.81 in men and 0.78 in women. Between the oldest (80 or older) and youngest (younger than 50) age groups, HUI differed substantially: by 0.40 for men and 0.39 for women.

Growth curve models

The first set of growth curve models (Table 3, Model A) examined transformed HUI3 (tHUI3) scores in relation to linear, quadratic and cubic age. For both sexes, the addition of smoking status resulted in significant improvements to the models in predicting tHUI3 scores (Table 3, Model B). The intercept parameters reflect differences at age 57—the point at which age was centred.

At age 57, men who were daily smokers had significantly lower tHUI3 scores than did those who had never smoked daily. Men who had quit for fewer than 20 years also had significantly lower tHUI3 scores than did those who had never smoked daily. Differences appeared to narrow as the number of years since quitting increased—the tHUI3 score of men who had quit for at least 20 years was similar to the score of those who had never smoked daily. None of the interactions between smoking status and age (linear, quadratic or cubic) were statistically significant, meaning that all men, regardless of smoking status, shared similar changes in tHUI3 as they aged.

Women aged 57 who were current daily smokers or former smokers (despite of the number of years since quitting) had lower tHUI3 scores than did those who had never smoked daily, although the differences were smaller for those who had quit for at least 10 years than for those who had quit for a shorter time. Uniquely in women, interactions between smoking status and rates of change in tHUI3 over time were statistically significant (Model C). Significant negative associations emerged for the interaction between age and having quit for 4 or fewer years and for 5 to 9 years. This means that former smokers who had quit for fewer than 10 years had a sharper decline in tHUI3 scores than did current daily smokers, former smokers who had quit for at least 10 years, and never daily smokers. No significant interactions were observed between smoking status and quadratic or cubic age.

To illustrate the results, estimates from the final models (Model B for men and Model C for women) were back-transformed and plotted. For men aged 57 who had never smoked daily, the predicted HUI3 score was 0.94; those who had quit for at least 20 years had a statistically similar score (0.93) (Figure 1).

Table 2
Percentage distribution of smoking status (time 1) and mean Health Utility Index (HUI3) score (time 2), by age group (time 2) and sex, 1994/95 to 2010/2011

	Smoking status (time 1)						
		Former daily smoker					
		Years since quitting daily smoking					
	Current daily smoker	4 or fewer	5 to 9	10 to 19	20 or more	Never smoked daily	Mean HUI3 (time 2)
Men							
Number of observations	3,967	1,365	1,215	2,592	5,137	4,363	18,639
	Percentage distribution of smoking status (time 1)						
Total	20.5	7.5	6.8	14.0	26.5	24.8	0.81
Age group							
41[1] to 49	32.8*	8.5	8.6	16.1*	6.4*	27.7	0.91*
50 to 59	25.1*	8.1	6.7	14.6	18.1*	27.4*	0.87*
60 to 69[2]	18.3	8.0	7.1	12.7	31.1	22.8	0.84
70 to 79	12.5*	5.9*	5.9	13.7	41.2*	20.7	0.73*
80 or older	6.3*	4.9*[E]	4.9*	12.9	46.3*	24.8	0.51*
Women							
Number of observations	3,785	1,270	1,059	2,137	4,225	11,575	24,051
	Percentage distribution of smoking status (time 1)						
Total	15.1	4.7	4.3	8.6	16.9	50.4	0.78
Age group							
41[1] to 49	24.8*	5.2	5.7	10.5	6.7*	47.1	0.88*
50 to 59	19.5*	5.9	4.4	10.0	13.4*	46.9	0.86*
60 to 69[2]	15.0	4.8	5.0	8.0	18.8	48.4	0.84
70 to 79	10.8*	4.0	3.4*	8.3	22.6*	50.9	0.75*
80 or older	4.4*	2.7*	2.6*[E]	5.6*	20.5	64.1*	0.49*

[1] because interval between interviews may have been less than exactly two years, at time 2 a few respondents were only 41
* significantly different from reference category ($p<0.05$)
[2] reference category
[E] use with caution
Source: 1994/1995 to 2010/2011 National Population Health Survey, longitudinal sample (square)

Table 3
Beta coefficients relating age and smoking status to health-related quality of life score (HUI3),† by sex, household population aged 40 or older in 1994/1995, Canada excluding territories

	Men		Women		
	Model A (effect of age)	Model B (effects of smoking status on intercept)	Model A (effect of age)	Model B (effects of smoking status on intercept)	Model C (effects of smoking status on rate of change)
Baseline (age 57‡)					
Intercept	1.051958***	1.131771***	1.012339***	1.076350***	1.073303***
Smoking status					
Current daily smoker	..	-0.164788***	..	-0.158754***	-0.156027***
Former daily smoker					
Years since quitting daily smoking					
4 or fewer	..	-0.190632***	..	-0.189913***	-0.171469***
5 to 9	..	-0.113097***	..	-0.161116***	-0.126985***
10 to 19	..	-0.088771***	..	-0.047525*	-0.045746*
20 or more	..	-0.026894	..	-0.046070**	-0.047191**
Never smoked daily§	..	..	..	..	..
Rate of change					
Linear	-0.009506***	-0.010681***	-0.005271***	-0.006063***	-0.005316***
Interaction with					
Former daily smoker					
Years since quitting daily smoking					
4 or fewer	..	..	..	..	-0.004468**
5 to 9	..	..	..	..	-0.008378***
Quadratic	-0.000036	-0.000002	-0.000078	-0.000087	-0.000097
Cubic	-0.000015***	-0.000017***	-0.000018***	-0.000018***	-0.000018***
-2 log likelihood	29,669.84	29,310.23	38,686.04	38,237.24	38,198.43

† based on arcsine-transformed values
‡ age centred at 57
§ reference category
* significantly different from reference category/zero (for age) ($p < 0.05$)
** significantly different from reference category/zero (for age) ($p < 0.01$)
***significantly different from reference category/zero (for age) ($p < 0.001$)
.. not applicable

Notes: In men, none of the interactions between smoking status and age (linear, quadratic or cubic) were statistically significant. In women, none of the interactions between smoking status and quadratic and cubic age were significant. When "Never smoked daily" was used as the reference category, statistically significant interactions were observed only for those who had quit for 4 or fewer years or 5 to 9 years. A final model was run retaining these interactions and using the combined other smoking status groups as the reference category.

Source: 1994/1995 to 2010/2011 National Population Health Survey, longitudinal sample (square).

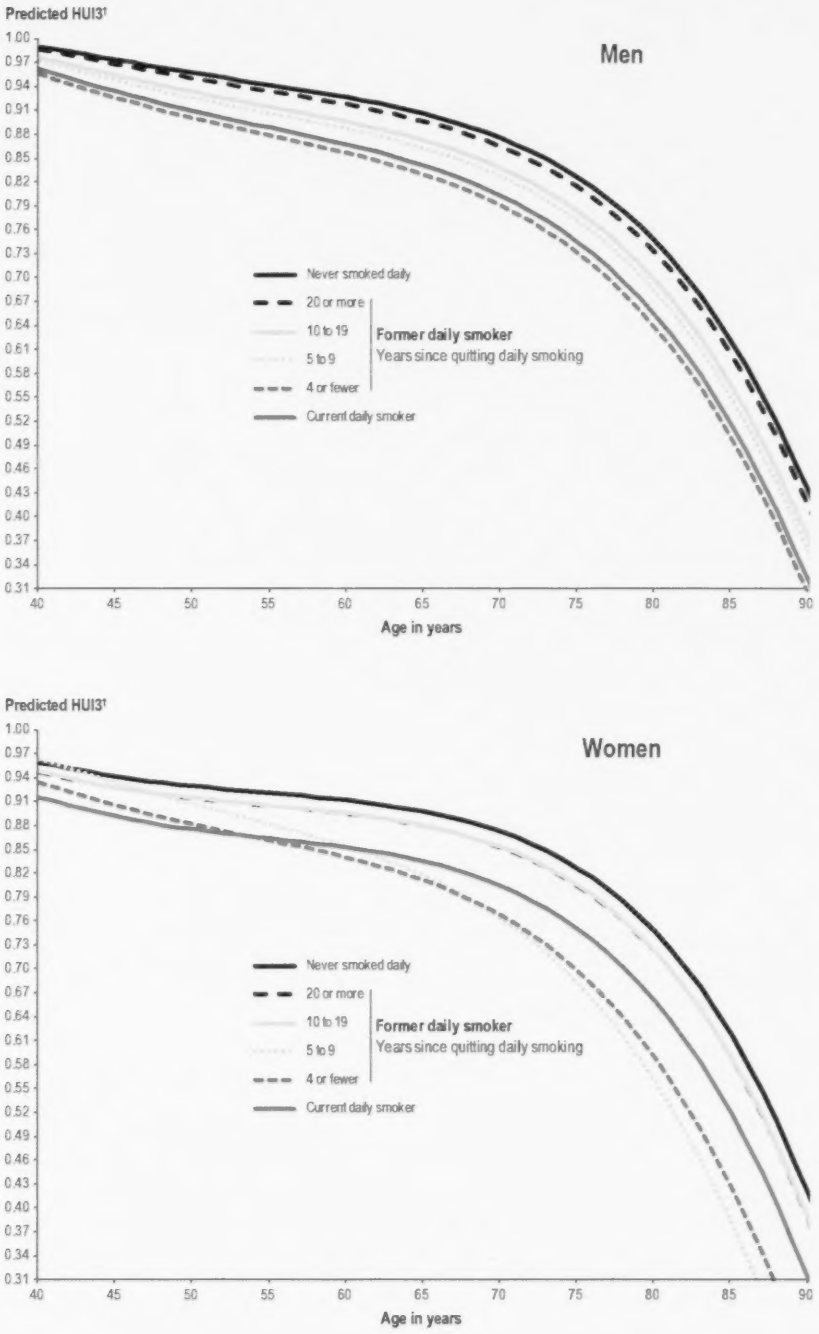
Predicted HUI3 scores were 0.88 for current daily smokers, 0.87 for those who had quit for fewer than 4 years, 0.90 for those had quit for 5 to 9 years, and 0.91 for those who had quit for 11 to 19 years. Significantly lower HUI3 scores for current daily smokers and former smokers who had quit for fewer than 20 years prevailed across all age groups, with no significant age-related changes in HRQL by smoking status.

For women aged 57 who had never smoked daily, the predicted HUI3 score was 0.92, compared with 0.86 for current daily smokers, 0.85 for those who had quit for 0 to 4 years, and 0.87 for those who had quit for 5 to 9 years (Figure 1). The scores of women who had quit for 10 to 19 or for 20 or more years were significantly higher than the score for current daily smokers (Table 4, Model A). However, the predicted HUI3 scores for these groups of quitters were within 0.03 units of the scores for women who had never smoked daily, indicating that the differences (from never-daily smokers) were not clinically meaningful. The negative interactions with age observed for those who had quit for 4 or fewer years or for 5 to 9 years are reflected in larger decreases in HUI3 scores over time. For example, the gap in HUI3 scores between women who had quit for 4 or fewer years and those who had never smoked daily widened from 0.07 at age 57 to 0.13 at age 75; among those who had quit for 5 to 9 years, the gap widened from 0.05 to 0.15.

When the control variables (household income, education, marital status and obesity) were included in preliminary models, the associations between smoking status and tHUI3 were minimally attenuated, and significance was not lost (data not shown).

To investigate the possibility that the benefits of smoking cessation might be due to lower smoking intensity among

Figure 1
Predicted health-related quality of life (HUI3)† scores, by smoking status, sex and age, household population aged 40 or older in 1994/1995, Canada excluding territories



† back-transformed predicted HUI3 score
Source: 1994/1995 to 2010/2011 National Population Health Survey, longitudinal sample (square)

former smokers than among those who continued to smoke, supplementary models were run controlling for the number of cigarettes smoked per day. However, compared with the tHUI3 scores for current smokers, the higher values for those who had quit smoking (Table 4, Model A) persisted when controlling for smoking intensity in both men and women (Model B).

Discussion

The major finding of this study is that long-term smoking cessation results in improvements in HRQL at any age. Among men who were former daily smokers, HRQL at 20 years of cessation was similar to that of never-smokers. Among women, at 10 years of cessation, former smokers' HRQL did not differ in a clinically meaningful way from the HRQL of never-smokers.

The relatively low HUI3 scores of recent quitters (4 or fewer years) were expected. Quitting smoking is a common response to the onset of illness; for example, a new diagnosis of vascular disease is predictive of smoking cessation.[2,3,16] Among women who had quit daily smoking for 4 or fewer years or for 5 to 9 years, the age-related decline in HUI3 was more pronounced than that among women who had never smoked daily (as indicated by the significant interaction with age for these groups). By contrast, among men, although the HUI3 trajectories for these groups were consistently below the trajectory for those who never smoked daily, they did not widen with age.

This difference between men and women may reflect differences in the incidence of and response to smoking-related chronic conditions. For example, a recent systematic review concluded that women who smoke have a greater relative risk of coronary heart disease than do male smokers.[17] To investigate the possibility of differences between the sexes in the effect of heart disease on HRQL, age-specific differences in HUI3 scores among people with and without heart disease were examined. The differences

Table 4
Beta coefficients relating age and smoking status to health-related quality of life score (HUI3),† by sex among current and former daily smokers, household population aged 40 or older in 1994/1995, Canada excluding territories

	Men		Women	
	Model A	Model B (effects of smoking intensity)	Model A	Model B (effects of smoking intensity)
Baseline (age 57‡)				
Intercept	0.970116***	1.040797***	0.914962***	0.945185***
Smoking status				
Current daily smoker§				
Former daily smoker				
Years since quitting daily smoking				
4 or fewer	-0.022932	-0.021320	-0.020195	-0.021310
5 to 9	0.045723*	0.055032*	0.021574	0.023818
10 to 19	0.075224***	0.086432***	0.104222***	0.105696***
20 or more	0.139611***	0.137711***	0.123231***	0.118209***
Number of cigarette smoked per day	..	-0.003522***	..	-0.001785*
Rate of change				
Linear	-0.011655***	-0.011772***	-0.006666***	-0.006680***
Interaction with:				
Former daily smoker				
Years since quitting daily smoking				
4 or fewer	..	..	-0.003883*	-0.004017*
5 to 9	..	..	-0.006827**	-0.006890**
Quadratic	-0.000028	-0.000015	0.000001	0.000007
Cubic	-0.000014***	-0.000015***	-0.000021***	-0.000021***
-2 log likelihood	23,333.92	23,665.06	20,137.57	20,116.67

† based on arcsine-transformed values
‡ age centred at 57
§ reference category
* significantly different from reference category/zero (for age and number of cigarettes smoked per day) ($p < 0.05$)
** significantly different from reference category/zero (for age and number of cigarettes smoked per day) ($p < 0.01$)
*** significantly different from reference category/zero (for age and number of cigarettes smoked per day) ($p < 0.001$)
.. not applicable
Source: 1994/1995 to 2010/2011 National Population Health Survey, longitudinal sample (square)

What is already known on this subject?

- Cigarette smoking causes numerous chronic conditions and premature death.
- Although many studies have examined smoking cessation in relation to reductions in the risk of incident disease and premature death, few have examined changes over time in health-related quality of life (HRQL) by smoking status.

What does this study add?

- At all ages, and for both men and women, HRQL improves substantially following long-term smoking cessation.
- In men, improvements to HRQL are evident after 5 years of smoking cessation; after 20 years, HRQL is similar to that of never-smokers.
- In women, HRQL is clinically similar to that of never-smokers after 10 years of cessation.

were consistently larger for women than for men, suggesting a stronger impact of heart disease on women's HRQL, or at least in those who survive with the disease.

In interpreting the HUI trajectories for recent quitters (4 or fewer years), the high rate of mortality of men and women is relevant. Compared with those who never smoked, the age-adjusted relative risk of death over the next two years among recent quitters was 2.8 for men and 2.7 for women (data not shown). Thus, substantial numbers of recent quitters did not survive to realize the benefits of long-term cessation.

The overall findings of this study are generally consistent with those of several cross-sectional studies, suggesting that current smokers have a lower quality of life than do non-smokers.[18-22] Cross-sectional research that included information from ex-smokers on time since quitting showed modest associations with quality of life.[23,24]

Studies using a prospective approach to measuring associations between smoking status and HRQL have typically been limited to one or two follow-up assessments, and time since cessation has often not been taken into account.[25-31] Nonetheless, some of these studies have reported a gradation in HRQL outcomes, with never-smokers and quitters faring better than continuing smokers.[25,28-30]

Not all prospective research has shown smoking cessation to benefit HRQL. In particular, studies of patients with cardiovascular disease at the outset of observation[26,27,31] found no difference in HRQL at follow-up between quitters and continuing smokers. In two of these studies, follow-up was limited to one year, and therefore, the findings are consistent with the results of the present study. Moreover, another longitudinal study based on the NPHS found that it took 20 years for former smokers' heart disease risk to decline to that of people who never smoked daily.[32]

Limitations

Several factors limit the interpretation of the findings of this study. People in relatively poor health may be under-

represented in the sample if they were more likely to refuse to participate in the survey or were lost to follow-up more readily, compared with people in better health.[5] Any bias that might result from this loss to follow-up is unknown. Similarly, the effect on the findings of record deletions due to non-response is unknown. Although information on smoking status was collected every two years, no data were available on changes in smoking behaviour that may have occurred between survey interviews. For example, a respondent who reported being a former smoker in two consecutive cycles may have relapsed to become a daily smoker in between interviews. Finally, the degree to which imputing smoking status may have affected the study results is unknown.

Conclusion

This study is strengthened by the longitudinal nature of the NPHS, its rich array of variables, and the frequency and number of follow-up years. These features address important methodological shortcomings of previous research, including failure to account for changes in and misclassification of smoking status and inadequate follow-up. This analysis provides evidence that long-term quitters can achieve a HRQL similar to that of people who never smoked. These findings underscore the benefit of quitting smoking, and specifically, the advantage of longer-term over shorter-term cessation. ■

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